REMARKS

Claims 1-11, all the claims pending in the application, stand rejected. Claims 3, 5, 8 and 9 have been amended. Claims 12-21 have been added. Claims 6 and 7 have been placed in independent form without substantive change.

Claim Rejections – 35 USC 103

Claims 1 and 3-11 are rejected under 35 USC 103(a) as being unpatentable over Foreman (5,521,444) in view of Corcoran (5,031,992). This rejection is traversed for at least the following reasons.

The present invention, particularly as recited in independent claim 1, is directed to a rotary contact-less connector that includes a combination of a rotary transformer (1) having a rotor (3) and stator (5), coupled with a rotary-side light-emitting/receiving element (8) and stationary-side light-receiving/emitting element (11). Electric power is supplied to the rotor (3) through the transformer (1) to permit operation of the optical device on the rotor. Power of the transformer (1) is divided between an electric circuit (9) and a power storage means (12).

As illustrated in Figs. 5-9, various embodiments of an arrangement of rotating-side elements 8 and stationary-side elements 11 are disclosed and facilitate single or multi-channel data communication between optical elements in a contact-less matter.

The present invention is the result of an innovative <u>combination</u> of two basic technical features. One is an Optical Communication feature, and the other is an Electrical Power Transfer feature. The combination of these two technical features was first implemented by the inventors and has significant and heretofore unachieved consequences. As to the Optical Communication feature, the present invention implements a switched communication between a rotating element

or elements and stationary element or elements, the elements being light transmitting and receiving components. The Optical Communication feature further permits a simultaneous bi-directional communication across the interface between the rotating element and stationary element. Details of the Electrical Power Transfer feature also enhance the beneficial result.

The Examiner looks to Foreman for a teaching of a device for transferring electrical power from a stationary member to a rotatable member via an air core transformer having first and second coils (10, 12), as illustrated in Figs. 2 and 4. As explained with regard to Fig. 5, power from source 60 is provided to the stator 10 via converter 70 and is transferred inductively to the rotor 12, which supplies electronics and other load elements 98 that are disposed on the rotor, as explained at col. 6, line 19 - col. 7, line 8. As disclosed at col. 6, lines 54-58, the electrical components may comprise sensors, actuators, electrical control devices and a microprocessor. As expressly stated at col. 6, lines 64-67, DC power can be provided to the electrical components 98 without requiring the provision of brushes or other contact methods to transfer power from a stationary source to a rotatable member. Finally, at col. 7, lines 19-23, the patent teaches that the structure could be used to transfer power from virtually any stationary component to any rotatable component.

Claim 1 – Defines A Patentable Combination of Electrical Power Transfer and Optical Communication Features

<u>Electrical Power Transfer</u> - At first, it is important to recognize that the present invention solves a problem that has existed with respect to the provision of power to an Optical Communication Device having a rotating part. The conventional practice in the art is to provide

continuous electrical power to the Optical Communication Device according to the following three techniques.

1) Without any Power transferring Device (e.g., replaceable battery)

2) With actual contact; Slip Ring

3) Wired; connect by wire

Applicants have implemented a non-contact Optical Communication Device that can continuously receive power for its operation. The device has both general and specific design features that preclude a combination of the cited art and expressly distinguish over the prior art. In this regard, claim 1 requires a rotary transformer that provides power to two paths, one a direct connection to an electronic circuit and the other an indirect connection to the electronic circuit through a storage means.

The Examiner asserts that Foreman discloses a rotary contact-less connector comprising a rotary transformer 80 (with reference to column 6,lines 35-36) that is composed of a rotor having a transformer rotary winding 12 and an annular stator that is concentric with the rotor (with reference to Fig. 2) and has a transformer stator winding 10. The Examiner also asserts that Foreman discloses that a power output of the rotary transformer 80 is divided into two outputs, one being directly coupled to the electric circuit 70, while the other being coupled to the electric circuit 70 through the intermediary of storage means composed of a capacitor or a storage cell (with reference to column 6, lines 19-68). Applicants respectfully disagree.

There is no "storage means" taught in Foreman, particularly a capacitor or storage cell. Moreover, the addition of such structure is not suggested, nor would it be an obvious element of a DC supply. Each of the wired or slip ring connections would simply rely on the continuous

transfer of power through the wired circuit and would not use a storage means, as this would add weight and mass to the moveable rotor and present balance problems that have no disclosed solution. Moreover, there is no optical communication structure in Foreman, as presently defined in claim 1.

Optical Communications – The Examiner looks to Corcoran for a teaching of an optical communication structure as claimed. However, Corcoran does not disclose the power transfer mechanism as stated in claim 1. Indeed, Corcoran is based on a conventional approach to transferring power by slip ring or the like, and does not consider a contactless power transfer mechanism as claimed. Corcoran is designed and sized for use in a video or data tape recorder (col. 1, lines 38-46) and would not wish to have the added weight or mass needed for a contactless transfer and storage of power. Nothing in Corcoran teaches or suggests that power may be transferred by a contactless mechanism, as in the present invention, and there is no motivation presented in the reference either. Corcoran is simply not concerned with the source of power. Indeed, Corcoran teaches away from a rotary transformer technology, which demands higher tolerances, as is clear from the discussion in col. 1, line 58-col. 2, line 16.

Accordingly, the subject matter of claim 1 should be considered unobvious and patentable over Foreman and Corcoran.

Claim 3- Defines a Patentable Switched Communication Feature

The technique for transmitting signals according to the present invention, as now defined in amended claim 3, is significantly different from that in Corcoran (note that Foreman has absolutely no relevant teachings). In Corcoran, as illustrated in Figs. 2 and 3, there is a plurality of light sources 31a~31d disposed at different radial positions on a rotor, and a plurality of

detectors 40a~40d on a stator, with concentric lens elements 35a-35d arranged to direct the light from the rotating sources onto the corresponding stationary detector. There is only one light source for each angular position of the rotor. Because of this arrangement, there is <u>no switching</u> in light flow, as the light from sources 31a-31d is continuously provided to the same detector. Moreover, the relation between each light source and its respective detector is fixed permanently (i.e., the method is <u>optical</u>, as the relation between light source 31a to detector 40a is fixed, even though source 31a rotates to multiple circumferential positions). Because of this fixed relationship, Corcoran requires use of a "multi-channel rotary optical coupler" (30), which comprises collimating lenses $33_a \sim 33_d$ and lens assembly to direct light from a plurality of rotational positions to a stationary detector in an array 40.

By contrast, according to the present invention, as illustrated in FIG.4 and disclosed at pages 12-14, the communication between each light source (e.g., 2.1) and a detector (e.g., 3.1) <u>will be switched</u> (e.g., light source 2.1 to detector 3.2 and then 3.3 with rotation of rotor). The relation between each light source and each detector will be switched in accordance with the relative rotation of the structures that contain the light source and light detector elements, and on the basis of switching signals from electronic circuits, such as circuit 9 (page.12 line 25 – page 13 line 7). In other words, the disclosed method is <u>electrical</u>, and includes a mechanism to switch the relationship of each light source and each detector in synchronism with their relative rotation. Embodiments that exemplify such switching are provided in Figs. 5-9 where the sizes and spacing of a plurality of light sources and detectors determine the timing of the switching function. In other words, the invention may be viewed as a novel and unobvious multiplexer.

In sum, the prior art, whether taken alone or in combination, does not teach the combination of power transfer and switched optical communication features as presently defined in claim 3.

Claims 4 and 5 - now depend from claim 3 and are patentable for similar reasons.

Claims 6 and 7 – Define Concentric Circumferential Arrangements of Elements

Original claim 6, which now has been placed in independent form without substantive amendment, specifies that the plurality of rotating side light emitting elements or light receiving elements are provided at concentric circumferential positions, and no element is provided at a center position. This limitation relates to the positioning of plural light sources 2.1, 2,2 and 2.3 on a common circumferential locus, as shown in FIG. 5 ~ FIG. 9, and the use of multiple concentric loci, each having plural light sources, as illustrated in Fig. 9. As would be clear to one skilled in the art, on the basis of the teachings in Figs. 5-9, it is very easy to position light sources in multiple groups, each different group on a respective concentric circle of Rotary Center P as shown in FIG. 5. As explained at page.12 line 25 - page.13, line 7, Applicants' invention when embodied with an arrangement of light elements or detection elements in concentric circles, will utilize a switching technique that controls the elements in accordance with rotational position and relative relation of the sources and detectors. Moreover, as subsequently explained and claimed, simultaneous bi-directional communication can be achieved.

Original claim 7, which also has been placed in independent form without substantive amendment, is similar to claim 6 in its recitation of a concentric arrangement of elements, but

specifies also that there also is a central detector and light source. This claim is patentable for reasons given with respect to claim 6.

Claims 8 and 9 – Define Common Circumferential Arrangement of Plural Elements

Original claims 8 and 9, which define a plurality of light emitting or light receiving elements provided in a radial direction of the rotor, have been amended to clarify state that the plurality of elements are at a common radial distance, at least as in Figs. 7 and 8. This arrangement is described for one exemplary embodiment at page 14 as providing the elements on the same or a common circumference. Of course, there could be a plurality of elements in plural circumferential arrangements, each at a different radial distance from the center axis of rotation, as in Fig. 9.

In framing the rejection of the original claims, the Examiner asserts that it would have been obvious for one having ordinary skill in the art at the time of the invention to merely orientate the elements from a circumferential direction to a radial direction to adapt to the mechanical configuration required for the contactless connector. This assertion is erroneous in several respects. First, the arrangement in Fig. 3 of Corcoran is <u>radial</u> and is not circumferential. Thus, the Examiner's analysis based on an obviousness between a circumferential and radial arrangement is not applicable. Second, there is only one light source at each radial distance, and not a plurality of elements as claimed. This is an essential difference, as the use of plural elements at a common radial distance requires switching to be effective. As already noted, no such switching is provided or even suggested in Corcoran. Thus, claims 8 and 9 as amended are clearly patentable over the teachings of the prior art.

Claim 10 – Defines A Patentable Non-Rotary Arrangement

Claim 10 defines light transmitting and/or light receiving elements on two stationary devices, in combination with a transformer for transferring power. As already noted, Foreman does not concern optical communication. Corcoran only concerns a rotary optical communication device. There is no consideration of power transfer by transformer coupling. Thus, the present invention would be patentable over the cited art, as thee is no teaching or suggestion of the combination as claimed.

Claims 11 - 14 – Define A Patentable Switching Circuit Feature

These claims expressly recite a switching circuit for switching the elements. As explained with regard to claim 3, this feature is not found in the prior art. Moreover, it would not be obvious on the basis of Corcoran because the reference is concerned solely with a permanent and fixed communication between the light sources of Fig. 3 and the detectors of Fig. 6. There is no teaching or suggestion of switching and, moreover, switching would be unnecessary and incompatible with the permanent relationship required by the Corcoran arrangement.

Claims 13-14 – Define Simultaneously Bi-directional Optical Communication – This feature also has been added in claims 13 and 14, which are dependent from claims 11 or 12, and further limit the rotary contactless connector with switching circuit. Clearly, this feature is not taught in the prior art, and the Examiner's observations to the contrary do not consider the requirement that the bi-directional communication be simultaneous. In Corcoran, there is a flow of light are from light source $31_a \sim 31_d$ to detector $40_a \sim 40_d$ only. There is a description that bi-directional flow is also possible $40_a \rightarrow 31_a \cdots 40_d \rightarrow 31_d$ (Column 8 line 10·~ 20), but no description of simultaneously bi-directional communication. As disclosed at pages 14 (lines 10, 16) and 18 (line 6), Applicants' system can communicate in two directions at the same time.

Specifically, when a light sources on the rotor is sending signals to a detector on stator, a light source on the stator can send signals to a detector on the rotor simultaneously. In either or both cases, there may be a plurality of light sources and detectors, and the communications can be switched.

Claim 2 is rejected under 35 U.S.C. § 103(a) as being unpatentable over Foreman (5,521,444) in view of Corcoran (5,031,992) in view of Everingham (5,811,898). The Examiner admits that Foreman in view of Corcoran does not disclose a nonmagnetic and nonmagnetized bearing. The Examiner looks to Everingham for such structure, as disclosed at col. 2, lines 33-37. The Examiner asserts that it would have been obvious to one having ordinary skill in the art at the time of this invention to provide bearings wherein a nonmagnetic and non-magnetized bearing is provided between the rotor to the annular stator to reduce the magnetic torque changes due to the magnetic field coupling. This rejection is traversed for at least the following reasons.

First, the claim is patentable because of its dependency on claim 1, which has been demonstrated to be patentable. Second, the claim recites a bearing, which has a particular and significant function in the present invention. In this regard, it should be noted that nonmagnetic and non-magnetized bearings are used for at least two functions, one is to reduce friction and another is to support load.

Applicants' bearing, as described in at page 15, lines 13-20 (as quoted bellow) is not introduced for these purposes (to reduce friction and to support load) as in Everingham, but is specially introduced for yet another purpose. Specifically, the bearing is introduced into the claimed rotary contactless connector to improve the precision between the rotor and annular

stator. In this regard, the function of Applicants' bearing is entirely different from Everingham's bearings, as is evident form the following quote from the application at page 15, lines 13-20:

> The nonmagnetic and non-magnetized bearing 6 is disposed between the annular stator 5 and the rotor 3. If the bearing 6 is not used, then it is possible to connect the rotor 3 to a rotating member of an apparatus to which the connector is applied, and connect the annular stator 5 to a stationary member of the apparatus, to which the connector is applied, thereby positioning the rotor 3 and the annular stator 5.

As a second difference, Applicants are using the bearing 6 (Fig. 1) to secure a precise minimum air-gap to obtain maximum power transmission in an arrangement shown in FIG 3. Generally the amount of power transmitting is inversely proportional to a square of GAP, so it is very important to keep the GAP minimum. By using a bearing, Applicants can obtain 10 or less μm GAP, while conventional structures have a GAP of over 100 μm). Foreman, as admitted by the Examiner, does not use a bearing and, thus, cannot achieve the precision offered by the Applicants' invention. Everingham does not teach or suggest the use of bearings in a Foreman environment to achieve better power transfer performance. Moreover, there is no teaching or suggestion of the use of bearings to achieve better optical performance.

New Claims

New claims 12-21 have been added in order to round out the scope of protection to which the Applicants' are entitled, on the basis of Applicants' review of the art cited by the Examiner. By way of background, and with reference to the illustrations in the essence of Applicants' invention is as follows.

The goal of the inventive structure is to achieve continuous optical communications by emitting and receiving of a signal between a fixed side equipment and a rotation side equipment, using light emitting elements and light receiving elements on the fixed side and the rotation side. This goal is achieved by following basic design conditions, as will be understood from the disclosure with regard to Figs. 5-9, particularly Figure 5 and Figure 6, and the accompanying disclosure at pages 11-13:

1) An arrangement of optical elements for continuous operation is established whereby on a rotor and/or stator, light emitting elements and light receiving elements are arranged such that a detectable area composed of light receiving elements is circumferentially disposed in a continuous arrangement.

2) With this arrangement, two light emitting element outputs do not enter the range of one light receiving element at the same time.

3) Also, one light emitting element output enters the range of two light receiving elements at the same time.

4) To provide continuous optical communication, a switching condition is defined appropriately between two light receiving elements.

While these features are evident from Figs. 5 and 6, Applicant has provided for the Examiner's convenience the attached Figure A, which shows a geometrical arrangement to satisfy these design conditions.

First of all, it explains the case of $R \geq r$ based on Figure A-a.

D: this is the radius of a locus of a circle, measured from rotational axis P, where light receiving elements are installed

R: this is the radius of circle that shows the detectable range of a light receiving element, e.g., 3.1, 3.2, and 3.3 ···

r: this is the radius of circle that shows output range of a light emitting element 2.1, 2.2, and 2.3 ···

On the surface composed of receiving elements,

θ; $\tan^{-1}(r/D)$

α; $\tan^{-1}(R/D)$, where

n: Number of light emitting elements on the circle of D in radius

m: Number of light receiving elements on the circle of D in radius

The next relation is obtained as below if the characteristics are defined as above.

$2\,\alpha m \fallingdotseq (2\theta + 2\alpha)n = 360°$

It becomes $\alpha \geq \theta$ in the case of $R \geq r$ for figure A-a.

It becomes m=6 via $2m \fallingdotseq 3n$ if it is required the number of optical communication channels. The number n of light emitting elements would be equal to 4 where $\alpha = 2\theta$, for instance. Also, if $n = 6$ and $\alpha = 2\theta$, then m=9.

Figure 5

The correspondence of this explanation to Figure 5 may be evident from the text at pages 12-13 of the application, quoted below.

> In the case shown in Fig. 5, the four rotating-side light emitting elements 8 are set to 2.1, 2.2, 2.3, and 2.4 to assign them to channel 1, channel 2, channel 3, and channel 4, respectively. The output range of light emitting element 8 at the surface of the stationary-side light receiving elements 11 is denoted by a radius

"r". Since four-channel outputs are required, it is necessary to provide four rotating-side light emitting elements 8. In order to restrain the occurrence of interruption and interference in receiving data, it is required to provide six stationary-side light receiving elements 11 (3.1, 3.2, 3.3, 3.4, 3.5, and 3.6) of the light receiving radius "R" at the apexes of an equilateral hexagon about a rotational axis. Referring to Fig. 5, when the rotating-side light emitting elements 8, 2.1, starts to enter the circle of the light receiving element 3.2 due to rotation, the rotating-side light emitting element 8, 2.2, which was in the circle of 3.2, will have left the circle by then. The output of the stationary-side light receiving element 11, 3.2, which has been for channel 2 until then, is switched to the output for channel 1 (the rotating-side light emitting element 8, 2.1) by a switching signal from the electric circuit 9. For the remaining channels, the outputs of the light receiving elements are switched in a similar manner in sequence as the rotation is carried out. This allows data communication to be accomplished without interruption or interference in the transfer of the output signals of the channels.

Figure 6

The correspondence of this explanation to Figure 6 may be evident from the text at page 13, for the case of r > R based on attached Figure A-b.

The condition of 1) has already consisted because it is the same as the case of Figure A-a.

Next, Applicants design the big circle shown in the broken line in Figure A-b as the circle of the light emitting elements. So, the big circle meets requirements of 2) and 3). Therefore, the next relation consists of

$2\theta \fallingdotseq 3\alpha \quad 2\alpha m \fallingdotseq (2\theta+2\alpha)\, n = 360°$

It becomes $\theta > \alpha$ in $r > R$ for Figure A-b.

If the number of optical communication channels is required to be n=4 as well as the above-mentioned now, it becomes m=10. Because $\theta>\alpha$, the actual number m of light receiving elements can be set to less than 10. As the light receiving elements 3.2, 3.4, ···in Figure A-b can be omitted, m=5.

Fig. 6 can be illustrated using the same method.

In sum, Fig. 5 illustrates the example wherein $R \geq r$, since the output range r of the rotating-side light emitting elements 8 is frequently smaller than the input range R of the stationary-side light receiving elements 11. Fig. 6 illustrates a case where $r>R$. In both cases, optical communication can be performed by switching the outputs of the light receiving elements in sequence on the basis of a rotational angle.

In view of the above, all of the claims should be considered patentable. Reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

Respectfully submitted,

Alan J. Kasper
Registration No. 25,426

SUGHRUE MION, PLLC
Telephone: (202) 293-7060
Facsimile: (202) 293-7860

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